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SIGMA XI QUARTERLY

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37th CONVENTION, ATLANTIC CITY
DECEMBER 29, 1936

IN THIS ISSUE

ALVAREZ ON ANCIENT FOLKWAYS AND MODERN MEDICINE

BOYDEN ON SEROLOGY AND BIOLOGICAL PROBLEMS

HALLOWELL ON ANTHROPOLOGY—PAST AND PRESENT

CIRCULATION THIS ISSUE OVER 13,500

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SIGMA XI QUARTERLY

VOL. 24 SEPTEMBER, 1936 No. 3

THE 37th CONVENTION

Chapters and clubs are urged to appoint delegates to the 37th Convention of our great Society, which is scheduled for Atlantic City, Tuesday, December 29, 1936, at 4 p.m. Among important items of business to be presented by the Executive Committees are:

1. Petitions for charters for chapters from:

a. George Washington University.
b. Carnegie Institute of Technology.
c. The University of Utah.
d. The State College of Oregon.

The printed petitions from these institutions will be sent to chapter secretaries early in November.

2. Proposed amendments to the National Constitution:

a. Article II, Section 2.

Present reading:

A petition for a charter for the establishment of a new chapter shall be communicated to the President of the Society who shall refer it to the Executive Committee for consideration. When the petition is reported by the committee, a three-fourths vote of the convention shall be necessary for granting a charter.

Proposed reading:

A petition for a charter for the establishment of a new chapter shall be communicated to the President of the Society, who shall refer it to the Executive Committee for consideration. If the Executive Committee presents the petition to the Conven-

tion with recommendation to favorable action a charter may be granted by a three-fourths vote of the Convention.

b. Add a new article to be numbered "Article III," as follows:

Article III, Section 1.

A Sigma Xi Alumni Club composed of local alumni members and alumni associates of the Society, may be organized at any place to engage in activities to further the objects of the Society. The recognition of such a local organization as a Sigma Xi Club shall require favorable action by the Executive Committee of the Society, and the Executive Committee shall have power to withdraw recognition of any club.

(Acceptance of this proposal will involve a change in the numbering of all articles following this article.)

c. Article VIII, Sections 1 and 2.

Present reading:

ARTICLE VIII

Conventions

Section 1. A regular convention of the Society, consisting of delegates from each chapter and from the alumni members of the Society, shall be held annually at such time and place as shall be determined by the Executive Committee and due notice shall be given to each chapter and to alumni members through the official journal of the Society.

Section 2. Delegates. (a) Each chapter in good standing shall be entitled to a representation of not more than three delegates at each convention. The members of the Alumni Committee shall ex-officio be the delegates representing the alumni members of the Society.

(b) The delegates representing any chapter shall be chosen from its chapter members; except that in case any chapter shall be unable to send its own members, it may appoint members of any other chapter as its representatives.

(c) In convention each chapter represented and each member of the Alumni Committee shall have one vote.

Proposed reading:

Section 1. A regular convention of the Society shall be held annually at such time and place as shall be determined by the Executive Committee, and due notice shall be given to each chapter, to each club, and to alumni members through the official journal of the Society."

Section 2. Delegates. a. Each chapter in good standing shall be entitled to a representation of not more than three delegates at each convention. The members of the Alumni Committee shall ex-officio be delegates representing alumni members of the Society. b. No change. c. No change. Add d. as follows:

Each alumni club shall be entitled to have not more than three delegates attend any convention. A club delegate shall have the privilege of the floor, to discuss any subject before the convention. Delegates of alumni clubs shall be entitled to vote only on questions directly affecting alumni members and associates. On such questions each club shall be entitled to one vote.

d. Article IX, Section 2.

Present reading:

Section 2. Alumni members and associates shall contribute to the support of the Society in such ways as may be agreed upon by the Executive Committee or the Alumni Committee. All sums so collected shall be separately accounted by the Treasurer of the Society and shall be known as the Alumni Fund.

Proposed reading:

Alumni members and associates, including those organized in clubs, shall contribute to the support of the Society in such ways as may be agreed upon by the Alumni Committee and the Executive Committee. All sums so collected shall be separately accounted by the Treasurer of the Society, and shall be known as the Alumni Fund.

The convention will be called upon to elect a member of the Executive Committee to succeed Dr. Henry V. Wilson whose term expires this year; and also a member of the Alumni Committee to succeed Dr. Henry G. Knight, whose term of office

expires this year. Nominations for these two offices are in order at any time and may be sent to the National Secretary who will hand them to the Nominating Committee, or to the Nominating Committee, which is as follows: Prof. B. F. Kingsbury, Cornell; Prof. Walter L. Upson, Washington University; Prof. Ralph W. Chaney, University of California.

Chapters and clubs should select their delegations at an early date. The National Officers are desirous that every chapter and club should participate in all the annual conventions of the Society. "Each chapter is entitled to a representation of not more than three delegates. In case any chapter shall be unable to send its own members, it may appoint members of any other chapter as its representatives." (Constitution, Article VIII, Section 2.) Clubs are invited by the Executive Committee to send representatives, who are accorded all the privileges of the floor in the discussions that may arise in the convention.

THE ANNUAL SCIENCE EXHIBITION

DECEMBER 28 TO JANUARY 1, 1937

The forthcoming Annual Science Exhibition in connection with the annual meetings with the A. A. A. S. to be held in the Atlantic City Auditorium from December 28 to January 1 is already assured a bigger and better performance than ever held before. The list of individual exhibitors is noteworthy. Among these Dr. C. A. Abbott will show an improved model of his solar engine which has already gained world-wide fame, Dr. W. F. Swann will have exhibits in cosmic rays, four Nobel Prize winners will participate, namely: Arthur H. Compton, Irving Langmuir, R. A. Millikan and Harold Urey. Prof. R. J. Anderson will have an interesting exhibit on the chemicals produced by tuberculous bacteria. Profs. C. T. Knipp, P. I. Wold and George B. Pegram will each have interesting demonstrations. Among the institutions and associations, The National Geographic Society will have a prominent display, beginning with the now famous gondola of the stratospher flight which will be in the lounge. Likewise there will be interesting displays by The American Dietetic Association, The American Institute of Physics, The American Medical Association, The American Nature Study Society, The Students Science Groups of America and The American Pharmaceutical Association. The Science Library will have all of the 1936 science books and the catalogue of these will be published in the book list of the American Library Association and in *School and Society*. The Hanovia Chemical and Manufacturing Company expect to have demonstrations of quartz blowing of unusual interest and the Warren-Knight Company will have demonstrations in the making of masks of the human lens and facial parts made at the exhibition. The exhibits in astronomy from many sources will be an outstanding feature, and the meteorological exhibits are expected to be the best that have been staged for many years. Altogether the exhibition alone will warrant attendance at the annual meetings.

In keeping with the exhibits in astronomy planned by Dr. Harlan T. Stetson will be a showing of newly developed science films by the University of Chicago through the medium of the University of Chicago Press.

REPORT OF COMMITTEE OF AWARD OF SIGMA XI GRANTS-IN-AID FOR 1936-37

The Committee of Award of Sigma Xi Grants-in-Aid for 1936-37 met in the Faculty Club of Harvard University, Cambridge, Massachusetts, August 20, 1936. The members attending were Professor Shapley and Professor Calkins. Doctor Whitney submitted recommendations in writing. The following awards were made:

C. W. Briggs, Assistant Professor of Biology, Dillard University, New Orleans, $250 for work on the biochemistry and physiology of medusæ.

Tze-Tuan Chen, Sterling Research Fellow, Yale University, $150, for work on "The Physical Basis of Heredity in Unicellular Organisms."

Calvin Springer Hall, Jr., Assistant Professor of Psychology, University of Oregon, $200, for work on "The Inheritance of Emotionality."

George William Hunter, 3rd, Assistant Professor of Biology, Wesleyan University, Middletown, Connecticut, $300, for work on "The Reaction of Host to the Penetration of Various Parasitic Worms."

Hubert M. James, Assistant Professor of Physics, Purdue University, $230, for work on "Wave Mechanical Computation of Molecular Forces and Computation of Nuclear Wave Functions."

Donald B. Lawrence, student in plant physiology, Johns Hopkins University, $300, for "Studies on the Submerged Forest on the Columbia River."

Donald H. Menzel, Assistant Professor of Astronomy, Harvard University, $150, for a rapid galvanometer to make possible high precision in the study of the spectograms obtained on the Siberian eclipse expedition.

Joseph Valasek, Associate Professor of Physics, University of Minnesota, $300, for completing a normal incidence vacuum spectograph in a study of absorption and fluorescence spectra of gases in the far ultra-violet.

W. R. WHITNEY,
HARLOW SHAPLEY,
GARY N. CALKINS.

THE EMERGENCE OF MODERN MEDICINE FROM ANCIENT FOLKWAYS*

WALTER C. ALVAREZ, M.D.

"In all matters relating to disease credulity remains a permanent fact, uninfluenced by civilization or education."

SIR WM. OSLER.

Some time ago when I began to arrange the notes for this lecture on the emergence of modern scientific medicine from the folkways of the past, the realization gradually came to me that it hasn't yet quite emerged, and that this fact would have to be taken into account in any discussion of the subject. What I came to see as I looked about me more thoughtfully was that although in its achievements and in its promise for the future, scientific medicine has immeasurably outdistanced the folk medicine, faith healing, cult medicine, and out-and-out quackery which has always competed with it, these competitors, which one would think might now be abandoned as superfluous, still flourish in the land, and still maintain their original hold on the affections of mankind.

As I shall emphasize later on in this lecture, a savage community usually has two types of medical practitioner: One, the witch doctor who cures by incantation and ceremonial and jugglery, and the other, the herb doctor and bone setter, who, according to his lights, practices much as does a scientific physician. Among the savages the witch doctor is usually held in higher esteem than is the herb doctor, and so also in the supposedly civilized parts of the world the quack often pulls in the crowds and waxes rich while the less spectacular but well-trained physician plods on without much acclaim.

For instance, a few years ago in the environs of Paris, crowds flocked to the booth of a man who was selling herbs to the accompaniment of an attractive and plausible line of patter. When the police arrested him for practicing medicine without a license, they discovered to their surprise that he was not a quack but really a licensed physician, and they were still more surprised when he begged them not to reveal this fact. As he said, if his customers were ever to hear that he was an educated physician they would all leave him, and he would have to go back to poverty.

PEOPLE VOTE FOR QUACKERY

In states which use the initiative and the referendum the people commonly vote down laws designed to debar ignoramuses from the practice of medicine, and sometimes they will go even further. Thus, in a certain city of this land, when a wealthy man presented the citizens with a much-needed hospital, they accepted the gift with the donor's proviso that the place be maintained always as a class A institution, that is, one in which only reputable and licensed physicians are allowed to see patients. But soon the few back-manipulators in town were protesting volubly that as taxpayers they had a right to practice in the

* Read at the open meeting of the Minnesota Chapter, January 24, 1936.

city hospital, and so the people went to the polls again and voted to break their covenant with the donor and to turn the building over to the back-rubbers. Hence, when last I had news of the situation, the regular physicians were out, and the town was back where it was before, without a satisfactory hospital.

Actually, the presence of this large group of people in some communities, unappreciative of, or militantly hostile to scientific medicine makes it impossible for health officers to stamp out diseases such as smallpox and diphtheria, against which, for years, science has offered adequate means of protection.

MANY GO TO IRREGULAR PRACTITIONERS BECAUSE REGULAR MEDICINE FAILED TO HELP

Now I know that there are several reasons for the great faith many people have in irregular practice by poorly trained and inexperienced men. I hate to spend time now in talking about these reasons but I fear that if I do not explain why I am not impressed with the cures worked by irregular practitioners and why I do not favor the licensure of such men as physicians, some of you will think me hopelessly biased and intolerant. I feel myself somewhat in the position of an astronomer invited here to describe the emergence of modern astronomy from ancient astrology. Knowing that many of you believe in astrology, he would not dare to speak disparagingly of it without going on to explain why he thought it a form of quackery which should have been left behind in the dark ages. He would feel all the more like giving this explanation if the present-day belief in astrology were hampering the development of astronomy in the great observatories of the world, much as the widespread faith in quackery is now blocking the efforts of health officers to eradicate disease.

Perhaps the main reason why quackery thrives today is that there are still so many diseases which the scientific physician cannot cure. I feel confident that eventually many of these will be conquered, but I doubt if my profession will ever be able to make over those millions of poor, broken-down men and women who either inherited bodies and nerves too frail to stand up to the strain of life or else had burdens laid on them heavier than they could bear. These people throng our offices every day begging for help, but in so many cases "the contractor put in poor materials," and the only way in which one could hope to work a cure would be to begin with a different set of grandparents.

Nor can the physician yet replace defective or worn-out parts, or parts already destroyed by disease when the patient comes for help. When a fire in a big conduit burns out some wires, and a part of a town is left in darkness, down the manholes go the linemen and soon new wires are strung. But when the poison of infantile paralysis has eaten a hole through the cable of nerves supplying the leg muscles of a little boy or girl, there is no way in which the neurologist can get in and repair the damage, and no one who knows what has happened would think of promising the poor worried parents a complete cure. Much that is helpful can be done by an expert orthopedist, but he cannot put back the injured nerve cells.

Similarly, the physician cannot take out grandmother's creaky knees and say, like an automobile repair man might do: "See there, the rubber cushions and

the oiling system are practically gone and the surface of the bone is burred over from much pounding, just as in the case of an old chisel. You'd better let us get you a new pair of joints from the factory!"

But some day surgeons will probably be replacing such parts because already they have developed the necessary technics. The only reason why they are not doing it now is that as yet, research workers have not learned how to keep the transplanted parts from being digested away by the blood of the recipient. But Doctor Stone has made a hopeful start towards overcoming this difficulty, and soon we may be putting new kidneys into the patient with Bright's disease, and perhaps even a new heart into the man whose cardiac arteries have begun to plug up with scar tissue.

In the meantime, the huge army of the weak, the unfit, the psychopathic, the crippled, and the ailing will ever be on the lookout for a worker of miracles. And one cannot blame them: they are desperate and ready to try anything once. They and their loved ones will always be scanning the horizon for hope, and they will always be ready to spend the last penny of their savings on a journey to the home of some new wonder-worker.

WHY QUACKS OFTEN APPEAR TO WORK MIRACLES

But some of you will remind me that sometimes the quack does cure after able physicians have failed. And you are right; I have seen this myself, but no one who knows anything of quackery, or human suggestibility, or hysteria, or the tendency of most diseases to let up without any treatment at all, is ever going to conclude that simply because a man is curing some people and is gathering crowds on his doorstep he is a good physician, and his system of practice is worth investigating or imitating. This statement will doubtless seem so paradoxical to some of you that probably I should digress for a moment and explain.

PATIENTS WHO CANNOT AFFORD TO GET WELL TOO QUICKLY

Occasionally I see patients who I feel sure could be cured more easily by some spectacular form of quackery than by my prosaic brand of psychotherapy. For instance: During the World War a young man's business necessitated his traveling back and forth through an ocean infested with German submarines. He went without protest, outwardly brave, but inwardly terrified. One day in Europe everything went black, and he returned home stone blind.

From the minute when I first saw him I felt that the blindness must be hysterical in nature. A man can hardly associate with the sick day after day for thirty years without learning the significance of many a little telltale sign, and as I expected, when I told him I thought he could be cured he showed no enthusiasm and soon departed.

Later, as I thought the problem over, I saw that I couldn't hope to cure him with undisguised psychotherapy because if I did, this would leave him in an embarrassing situation. It would expose him to the accusation of having been either a fool or a coward or a cheat. No, he could afford to get well only in some spectacular way, and I was not at all surprised some months later, when I saw by the papers that an irregular practitioner had reduced a dislocated vertebra in the neck, a vertebra that had been pressing, so they said, on the optic nerves.

As you know, these nerves do not go anywhere near the neck, but no matter—the fact appears to have been that the patient's sight was instantly restored.

Now imagine the effect of such a newspaper report on the minds of blind men and women everywhere: they who have gone to many oculists without help and without encouragement. It will immediately occur to some of them that perhaps they too have a displaced vertebra, and it certainly wouldn't hurt to look. And so they borrow what money they can or draw out their little savings, and off they go to see the new miracle man. The sad thing is that in ninety-nine such cases out of a hundred the eyes are hopelessly damaged, and the poor blind man must return home even more discouraged than he was before.

STRIKING PERSONALITIES THAT HEAL

Often the cure, when it does come from an irregular practitioner, is worked not so much by the massage or the manipulation as by the influence of an unusual and commanding personality. A few months ago while lunching at a club I couldn't take my eyes off a big, tall, striking-looking man, with piercing black eyes, long black hair shot with gray, and a strangely moving, deep and musical voice. I said to the friends with me, "What a wonderful quack he would make," and then they told me that actually he was a sort of faith healer. He was a preacher who discovered one day that he had the gift of healing by the laying on of hands.

Actually, all great physicians seem to possess some of this ability to inspire sick persons with confidence and hope, and to lift them up out of a bog of worry and fatiguing thoughts and to put them on the road to health.

CURES DO NOT JUSTIFY A QUACK

As I have already said, the fact that a healer is besieged by hordes of patients, many of whom depart singing his praises, does not indicate for a moment that his methods are rational or worth using by other men. In the hands of the next man they may fail utterly, and for that matter, they usually fail after a time even in the hands of the original user. For this reason nearly all forms of quackery have their day and then—lose ground and disappear.

Perkins' Tractors.—Thus, towards the close of the eighteenth century, Elisha Perkins, an American physician, was curing disease right and left with two little, supposedly magnetic, pieces of metal called tractors. He did so well that even George Washington got a pair. After Elisha died, his son took the tractors to England where he made a great stir and enlisted the support of the nobility. Unfortunately for him, the famous Doctor Haygarth was skeptical. First he held clinics at which he demonstrated how patients lost their pains when the affected parts were stroked with the tractors. Then, when everyone was much impressed, he took out his penknife and cut the supposed magnets in two; they were imitations made of wood. In the reaction that followed, all England laughed, and Perkins left for home.

Asuero.—In Madrid, a few years ago, an unimportant physician named Asuero announced that all diseases were due to trouble in a little nerve in the nose, and easily curable by local treatments. The idea caught on, and soon there was a line of people on the sidewalk each morning waiting to get into his office. As

commonly happens with quacks, the wealthy and the aristocratic made much of him, and in two or three years he accumulated a large fortune.

Then, apparently, he ran out of suckers, and with nothing to do, he left for Italy to see if he could start there all over again. But the Italians did not take to the idea, and when last I heard of the man, he had failed to get going even with the help of his old prestige, his wealth, and the support of some dukes and duchesses. His imitators also failed. Some of you may ask: But didn't the method have some value? Yes; it was nothing new. Nose specialists have used it for years, and with it have helped occasional cases of hay fever and headache.

Albert Abrams.—Another typical story is that of Albert Abrams, a licensed physician of no great reputation in California. For years he promoted a scheme for curing disease by pounding the spine with a little rubber hammer. But the idea never took hold, and until he was about sixty, Abrams had only a mediocre practice. Then one day as he sat looking at one of the first little radio sets, he got an idea that was soon to bring him in about a million dollars. He took a couple of cheap resistance boxes and an old Ford spark coil, hooked them together in the silliest way, and announced to the world that with this magic detector he could tune in on the electronic vibrations coming from a drop of blood and could tell exactly what disease the patient was suffering with. For good measure he would tell if the sample of blood came from a Chinese or a Jew, or from a Presbyterian or a Catholic! Just as easily he could connect the patient to another silly box of wires and tune the disease right out of him.

To people who were just beginning to realize what marvels the radio tube could perform, this all sounded so reasonable and so up to date that thousands flocked to him and paid a hundred dollars or more to sit for a while holding on to the end of a wire out of which was flowing—absolutely nothing. Many felt that they were cured, and writers like Upton Sinclair, who swallowed hook, line and sinker, wrote articles accusing the leaders of the medical profession of narrowness, backwardness, and jealousy, and an inability to recognize genius when they saw it. The fact that Professor Millikan, on the witness stand in a malpractice suit, swore that he had examined the instruments and that they couldn't possibly do what they were supposed to do, did not seem to discourage anyone.

And then Abrams died, and without his frequent startling pronouncements, which had served to keep his name in the newspapers, his disciples found themselves with but few patients, and compelled to shift over into some other better advertised and more popular form of quackery.

SELF-LIMITED DISEASES

But some of you may still be saying that you know of a man who was lying at death's door, and after treatment by some irregular practitioner got well. Yes, this happens all the time, and yet it usually proves nothing. Many is the time that I have received great credit for cures which I know good old Mother Nature had more to do with than I. I can remember one of the lucky breaks that came to me when I was a young man starting out in the practice of medicine. A man lay ill with pneumonia, and as usually happens in this disease, each morning

of the first week found him worse. Not knowing enough about the disease to expect this, the wife became convinced that the nice old doctor in attendance did not know his business, and dismissed him. I was then called, and I barely had time to change the medicines before the crisis came, and my reputation was made! I tried to explain to the people that they must not blame the old doctor because in this case the pneumonia had run a very typical course to recovery, but they thought I was just trying to be modest, and so finally I gave in, and said no more, salving my conscience with the conviction that sooner or later I would get my share of disgrace perhaps as undeserved as was my present credit. And so it happened; my next patient with pneumonia did so badly that I was dismissed; the old doctor was called in shortly before the crisis came, and thus he got even with me.

Now, you may smile at all this, but just remember that such things commonly happen when next you hear of a case like the one I will now describe. A nationally known educator lay ill with pneumonia. The ninth day came and no crisis, and because the physicians in attendance looked anxious and shook their heads ominously, the family discharged them and called in a back-adjuster who only a short time before had been a bath-house attendant. Next day the crisis came, and for the rest of his life that distinguished college professor, who should have known better, extolled to his friends the virtues of a certain cult and the skill of a certain ignorant but pleasant and well-meaning man.

Curing a Disease That Wasn't There.—Or here is the fairly common story of another type of case in which the irregular practitioner triumphs because either he or some good physician diagnosed wrongly. The case is that of a very wealthy woman who was operated on years ago for a tumor of the large bowel. It looked so much like an inoperable cancer that the famous surgeon in attendance did not attempt to remove it, but simply made a by-pass around it. Later, as more experience came to him, he realized that what he had seen was not a cancer at all, but only an inflammatory mass that would probably disappear after the type of operation that he had performed. But in the meantime, the patient had gone to a faith healer, and when years passed and she remained well, she built for this healer and her faith a beautiful church. Always, then, when one hears that some healer has cured a cancer, it is well to remember the possibility that the diagnosis was wrong.

Cures That Won't Work Twice.—And here is yet another type of case. Recently I saw a woman with a severe arthritis. She told me that five years before, when the disease first flared up and put her in a wheel chair, she went to a quack who cured her with the help of an herb tea. Naturally, I asked her why she wasn't back taking the same treatment again, and her answer was that she had gone but that this time the tea wouldn't work. The chances are, then, that the first spectacular cure was not a cure at all but only one of those spontaneous remissions which are so common in the course of a life-long disease.

THE DIFFICULTIES INVOLVED IN JUDGING OF THE VALUE OF A TREATMENT

The average layman has no conception of the pitfalls which lie in the path of the man who would appraise the value of some particular treatment, especially

for a self-limited disease. For instance, last October some of you doubtless took "cold shots" to protect you through the winter. If when summer comes you are still without a cold will that prove that the vaccine was helpful? Not at all; you may be delighted with what seems to you a miracle, but I can assure you that the reports of dozens of such successful cases means nothing to the medical statistician. The only way in which to learn anything definite about such a treatment is to do as the Metropolitan Life Insurance Company did several years ago. They took, as I remember, some 5,000 of their employees and vaccinated half of them, leaving the other half to serve as what we physicians call a "control series." At the end of the year they checked up and found that the 2,500 who had been vaccinated had had just as many colds as did those who weren't vaccinated; the only difference was in the severity of the colds, the vaccinated men and women getting back to work on the average several days sooner than the others did.

Some time ago, Doctor Diehl of the University of Minnesota made a splendid study of colds among the students, trying out on hundreds of them several of the drugs that are commonly used in this disease. He found to his surprise, that one out of every three colds will clear up in a day or two without any treatment at all, and others will clear up so rapidly or will run so mild a course that it is impossible to say whether or not the remedy given had anything to do with the prompt recovery.

No wonder, then, that practically everyone thinks he can cure a cold. Hasn't he cured many of them with his pet method? To be sure, some of the colds treated hung on stubbornly, but following the convenient rule of humankind, he forgot these and remembered only those which he "cured." And if he, who has had no training in medicine, can have had such splendid success in his little practice, why should anyone have difficulty in believing that other uneducated persons can cure disease, especially when they have inherited some special skill or some secret formulas for powerful remedies? So why should there be all this demand that physicians be educated men?

Actually, it is only the highly educated physician who finds it difficult to take seriously the pretensions of healers who have spent only a year or two in a low-grade college; he alone knows how hard it is to practice good medicine even after half a life time spent in study.

BELIEF IN THE MIRACULOUS INCULCATED IN EARLY LIFE

But there are yet other reasons, and very strong ones too, why all of us look for miracles when it comes to the treatment of disease. We may have spent four years at college learning that the universe is run according to immutable laws, but throughout our whole youth, and almost from the moment that we could understand speech, we were taught to believe stories of miraculous suspensions of these laws, and we were urged to ask daily that such miracles of protection be performed for us and for our loved ones.

Furthermore, in our daily contacts with the people about us and with the world of books, we absorb, willy nilly and unconsciously, much medical folklore which inevitably has an influence on our thinking and our behavior. And if it influences the behavior of an educated man, how much more must it dominate

the thought and the behavior of the ignorant and the naturally credulous? None of us can escape it. You sneeze, and some old person near you says, "God bless you." Why did she do that? She probably does not know, but her ancestors in Europe could have told us that you sneezed because a little devil was just then entering your body with evil intent, and when your friend called upon the name of God, that devil had to get out in a hurry. Unconsciously, you subscribe to the same idea when you say, "I wonder what possessed me to do that?" or "I wonder what can have gotten into that child."

Or let us suppose that, without thinking in time to stop myself, I remark to my wife that it is almost a year since I had a cold. I immediately rap wood, but why? Actually, on looking this up in my library on folklore, I found that I do not do it right. I really should be pounding so hard on a log and making so much noise while I am bragging that the devil will not be able to hear me and to say, "Watch me and see how I take that cocky fellow down a peg." Now isn't that silly, and yet I keep on rapping wood on every appropriate occasion, just because it makes me feel safer.

But you can't laugh at me because you have your own pet superstitions. Perhaps you have a horseshoe over the barn door to keep out the elves that would ride the horses all night and sicken the cows and poison the churn. Or let us suppose that you start to pick a sliver out of your finger with a pin and your grandmother catches you at it. You know that she will insist that you use a needle. But why? For twenty years I have been asking grandmothers that question. They all agree that one must use iron and not brass, but the two lame explanations which they give can easily be shown to be inadequate. I searched for years through the literature on folklore for information on this point until at last I became convinced that the original reason was that if iron is used it will keep the wicked elves away from the wound just as iron over the door will keep them out of the house. When you use a brass pin you have no protection, and the wound may fester.

But some of you may ask: Why should the iron protect? Briefly, it is because the elves and the old gods and demons were very conservative; so much so that for thousands of years they clung to the use of the old chipped flint axes and knives of our cave-dwelling ancestors. Eventually they got so that they could tolerate bronze, but even yet they cannot abide nor even go near the new-fangled iron which came into use about 1000 B. C.

Or, let us suppose that today, as a young mother sits trimming for the first time her baby's nails, the grandmother comes in. Why will she be so upset and why will she perhaps get down on the rug and pick up all the little parings so as to destroy them in the fire? Why will she say that for the first year of the baby's life the nails must be bitten off? Ask her and she will probably say that if this is not done the baby will grow up to be a thief or it will sicken and die. But let us ask the official nail-paring swallower of a Madagascar chief, I have read in scientific treatises that there is such a man, or let us ask any savage anywhere on the face of the earth, and he will tell us that when the nails are bitten off the pieces must be swallowed. If they were to be left around, and a bad witch were to get hold of a piece, she could easily say some spells over it, and disaster would soon come to the baby.

I never cease marvelling at the antiquity and the wide dissemination of scores of these beliefs. For instance, there are many poor homes in England today in which, if a child is seriously ill, the grandmother will want to administer a skinned mouse as a medicine. But why a mouse? To find out we have to go to Egypt where each year as the Nile subsides and the peasants go back to their fields, they find in the cracks in the mud an abundance of mice. They think that these mice sprang from the mud, and therefore must represent an essence of the life-giving virtues of the river. What is more appropriate, then, than to save a dying child with a medicine which represents life abundant? And now comes what, to my mind, is the most interesting part of the story, and this is that when Elliott Smith was studying the mummies of some little children who lived in Egypt over 6,000 years ago, long before the pyramids were built, he found in each of their stomachs—a mouse!

ANCIENT THEORIES OF THE CAUSATION OF DISEASE

Now it will be noticed in the examples which I have given of present-day medical superstition that disease is usually supposed to be due to the malevolence of the devil or of witches or wicked elves, or of men who know enough of the magic arts to summon help from the powers of darkness. What is more natural, then, than to assume that health is to be maintained by warding off evil in some magic or symbolic way.

But where did we get these ideas? I feel sure that we got them from our remote beetling-browed ancestors who hunted the reindeer and the woolly mammoth in the days when the great ice sheets were retreating northward toward the pole. But someone says: How can anyone know what those ancient savages thought? Well, we cannot know for certain, but here and there in the few remaining wildernesses, explorers come upon men who live in a stone age very similar to that of our ancient ancestors, and always these men are found to have about the same ideas in regard to disease. Never having heard of germs or high blood-pressure or hardening of the arteries, it never occurs to them that a man might die of natural causes. If he wasn't injured in an accident or mauled by an enemy or a wild beast, then he must have been harmed by witchcraft or he must have offended some deity or broken some tabu.

One of these ideas has come down to us embalmed in a word. Thus, when an old man drops to the floor unable to speak or to use his right arm and leg, we physicians say that a blood-vessel in the brain has either ruptured or been plugged in some way. But the layman says that it is a stroke, which implies that God was angry and reached out and struck the man down. I never realized how fully a college graduate could believe this until one day when, as I sat by the minister's wife, encouraging her to learn to talk again after a bad cerebral thrombosis, I found that the endlessly recurring question in her mind was: "Wherein have I sinned so terribly that God has struck me down in this cruel way; why has He done this to me who have served Him lovingly all my days?"

But to get back to the savages and their ideas of medicine: Seeing that to them disease is due purely to the malevolence of gods and witches, it is easy to understand why their most prized physicians are not expected to have any knowledge of the body or of surgery or of healing herbs; all they are asked to do is

to find out which god is angry and why, or which witch is at work and who is employing him. After that they must know how to appease the god, or to nullify the evil charms of the witch with yet stronger charms and spells.

THE TWO TYPES OF HEALER AND THEIR DESCENDANTS

And so it is that wherever on this earth one encounters primitive people one is likely to find that the most respected and most feared man in the tribe is the witch doctor. Often he is a sort of Pooh Bah who exercises the functions of physician, seer, prophet, priest, socerer, master of ceremonies, and perhaps even king. Sometimes he represents the finest flower of the development of his people, and then again he may be little more than a juggler and an assassin who will kill for a price.

But what happens when a savage falls out of a tree and breaks his legs, or comes back from a raid with part of his scalp hanging over his ear, or what is done to help the man who gets constipated or has a boil that needs lancing? Will the witch doctor bother with such small practice? No, that is usually beneath his notice, and hence in every tribe there is another kind of healer, a man or woman who can clean wounds and bring the edges together, who can splint a broken leg or pull a dislocated bone back into place, who can incise an abscess or knock out an aching tooth, who can massage stiff muscles or give a sweat bath, and who knows the lore of medicinal plants.

And here I get to the central theme of my discourse, and this is that from the time when man first stepped down out of the trees and made himself a stone axe down to the present moment, there have always been, in every community, two types of medical practitioner: One a believer in some supernatural or similarly unprovable and readymade explanation of disease as a whole; the other, a student of the many diseases as he finds them; the one disdainful of the study of the structures and workings of the human body; the other a deep student of these sciences; the one treating by means of charms and spells, ceremony, hocus pocus, exorcism, and sacrifice; the other treating with physical and chemical measures; one whose forte is the cure of nervous troubles, hysteria, and self-limited diseases; the other whose greatest success is found in the healing of those lesions such as deep wounds or bad fractures in which Mother Nature, unaided, either fails to cure or else ends up with a bad result.

THE CONSERVATISM OF THE WITCH DOCTORS

As one would expect, the descendants of the witch doctor have not changed their technic very much through the ages, and if tomorrow they were to be called upon to cope with some terrible epidemic their methods would be practically the same as those of their savage ancestors. They would doubtless begin as they did in biblical times, in the middle ages, and in the terrible winter of 1918, by fixing the blame on some group of persons who had offended the deity. Then there would be sacrifice and ceremony, solemn processions and pilgrimages and the making of vows, all undertaken with the hope of expiating sin and propitiating an angry God.

The average individual would keep his windows tightly closed at night to keep out the flying demons of disease, and he would certainly wear a protective amulet.

If during the epidemic, a savage were to come to our shores with some explorer, he would see nothing new in all this, and could only approve heartily of every detail.

THE PROGRESS MADE BY THE HERB DOCTORS

But now let us see what the descendants of the herb doctor did when, some thirty years ago, they were asked to send men to India to try to stop the bubonic plague which was raging there as it has done so many times in the past.

Did the physicians on that commission go into the temples and offer sacrifices to the hideous goddess of epidemic disease? No, they went to work with microscopes and guinea pigs. First, reckless of their lives, they opened the bodies of people dying with the plague, and studied the characteristic changes in the several organs. Then they put under the microscope a little juice from the enlarged glands in the groin, and always they found millions of tiny germs such as are never found in the tissues of normal persons. Then these germs were cultivated in glass tubes, and a drop of the culture was injected into a guinea pig, and when the animal sickened and died, the autopsy always showed lesions like those of the patients. And so, gradually, it became clear that the cause of the scourge was a living thing, a tiny germ which went into a man and kept multiplying until it killed him.

The next question was: How did this germ get into the people? Did they drink it or eat it or did it travel through the air? At this point the physicians were helped by a bit of knowledge that had been available for centuries, namely, that always, preceding an epidemic of plague, rats crawl out of their holes and die. Accordingly, hundreds of rats from the affected regions were caught and dissected, and in the sickly ones again there appeared the same lesions and the same little germs that had been found in the guinea pigs and in the patients. But how were the germs getting from the rats into the people? Soon the rats' fleas came under suspicion, and when some were removed from a rat dying of the plague and dissected, there again were the germs.

Then the scientists collected fleas from sick rats and put them on guinea pigs, and the pigs sickened and died of plague. They always got the disease also when they were left in cages on the floors of the huts where men were dying of plague and their fleas were hopping about looking for a new host. But when the cages were made of wire gauze too fine for the passage of fleas, or when ordinary cages were suspended some distance off the floor, too high for a flea to jump in, none of the guinea pigs succumbed.

At last, then, the essential facts about the disease were available, and bubonic plague could no longer rage as a terrible scourge up and down the earth. Now, whenever a few cases appear in a city, health officers rush in and destroy rats and fleas, and the epidemic is stopped before it can get well started.

I wish I had time to tell more of the fascinating stories of the detective work that has been done in tracking down one little messenger of death after another, and learning so much about its life habits that health officers can destroy it or stop it from propagating, but I must hurry on. Those who have read Zinsser's delightful book on "Rats, Lice, and History" and De Kruif's "Microbe Hunters" already know how fascinating these stories can be.

EVERY WORTH-WHILE DISCOVERY OF THE PAST IS USED TODAY

I must hurry on to point out a fact which to me is a source of pride, and this is that every worth-while discovery ever made and remembered, and every accurate bit of information ever obtained and passed onward by the ancient herb doctors and by all true students of disease throughout the ages is used in scientific medicine today. I feel that every well-educated regular physician today is the lineal descendant and heir of the old herb doctor and primitive surgeon, just as every faith healer and every irregular practitioner who treats all cases alike, and every ignorant quack who treats by hocus pocus of one kind or another is a lineal descendant of the witch doctor.

In my library I have translations of the two oldest medical papyri in the world. So far as scholars can tell, these two books date back to between two and three thousand years before Christ. The Smith papyrus was written by a remarkably modern surgeon who described the several types of fracture of the skull and the symptoms that go with each so clearly that we can follow him today. He sutured wounds and brought their edges together with adhesive tape; he knew that an injury to one side of the brain caused paralysis of the other side of the body, and he was often able to pick the patient who would die and the others who would probably get well. If he could only wake up today, to crawl out of his sarcophagus, I believe that a modern brain surgeon would find in him a helpful associate, and would defer to his judgment in the handling of many a wound.

The other ancient book, the Ebers papyrus, is not so satisfying today because the witch doctor had too much to do with writing it. It is largely a collection of prescriptions in which drugs are mixed with unpleasant things such as the dried excrement of men and animals. Why did they use such things? In order to make the indwelling demon of disease so disgusted that he would get out and not come back. Actually some of the prescriptions were labeled "for the expelling or *terrifying* of the disease."

The Chinese have the same idea today, and in the Flowery Kingdom, when a man lies desperately ill his relatives will sometimes hire orchestras to keep up such an infernal din all day and all night that the devil causing the disease will get worn out from lack of rest and sleep and will depart for a quieter place!

MIXTURES OF THE MAGICAL AND THE PRACTICAL

But to get back to the Ebers papyrus: As I have already pointed out, one finds there many instances of a very common medical practice, and this is the mixture of the magical and the practical. As one would expect, all through the ages the two systems have been combined more or less unconsciously by practitioners of the two types. Sometimes the witch doctor or the mental healer has used manipulations and even drugs, and the old herb doctor has taken care to gather his plants with a certain ritual or while mumbling spells, and only during certain phases of the moon. Furthermore, the herb doctor has often fallen from grace, scientifically speaking, and has prescribed a drug not because experience showed him that it was useful but perhaps because the astrologers believed that it and the disease to be treated were both under the protection

of the same sign of the zodiac. Or perhaps because a walnut looks like a brain with all its convolutions, the old doctor gave powdered walnuts for insanity; or he gave red medicines for anemia and yellow ones for jaundice. Or he shaved elder bark downward to get a cure for vomiting and upward to get a cure for diarrhea!

Archæologists who, years ago, unearthed the archives of an ancient king of Nineveh found two letters of great interest to the medical historian. One was from a magician telling his master, the king, of his illness and begging that a physician be sent to him, the other was from a prominent physician who had prescribed for the king. Unfortunately, the treatment did not help, later the physician wrote, admitting that he did not know what the trouble was; he went on to suggest that while the local physicians might continue to administer the medicines they had better call in a magician!

And so it goes today; the faith healer calls in an obstetrician to help with a difficult case of labor, the spinopath prescribes diet and insulin for a diabetic, and the regular physician cures many a hysterical patient with a combination of pills, impressive apparatus, suggestion, and personal magnetism.

THE DRUGS PHYSICIANS USE TODAY CAME FROM ALL OVER THE EARTH

One of the most interesting things about the Ebers papyrus is that it shows us that away back in that ancient time physicians were already using many of the drugs that we prescribe today. Aloes, senna, castor oil and epsom salts were being given for constipation, and peppermint and fennel for gas. To me one of the most curious prescriptions in the collection is the one for soothing a crying child. What do you think it contained? Nothing other than the opium which our government had to ban from American patent soothing syrups some twenty-five years ago. Incidentally, the ladies might like to try one of the old Egyptian formulas for Countess So and So's facial cream, guaranteed to remove wrinkles! They will be interested to know also that the ancient Assyrians treated halitosis, they dyed their gray hair, they used mustard plasters, and they put a piece of raw meat on a bruised eye!

THE TRUE PHYSICIAN USES EVERYTHING EVER FOUND USEFUL

And this leads to another one of the points I wish to make, which is that a scientific physician today uses gladly any drug and any method of healing that he can hear of that was ever found really useful by anyone anywhere. Let us go into a drug store and glance over the shelves. There we will find the castor oil, senna, ox gall, aloes and opium which were used in ancient Egypt; another purgative, magnesia, came originally from an ancient city of that name in Greece, jalap comes from Mexico, and cascara from California; the aspirin which is so popular today is first cousin to the smelly oil of wintergreen which our grandmothers used to put on flannel and tie around aching joints, and quinin and cocain and ipecac come from South America. Digitalis, our greatest heart medicine, came to us from an old English herb woman. When, a hundred years ago, Doctor Withering found that this woman was curing some patients whom

he had failed to help, he went to her and paid a good price for her secret. Then, like the true physician that he was, he purified it and gave it freely to the world.

Lest this story about Withering serve to strengthen the belief that many have that it pays sometimes to go to a Chinese herb doctor or to an American Indian or to a Hindu or some other foreign healer because he must know many things that the American physician does not know, especially about medicines of vegetable origin, I will say that there may have been something in this idea long ago but there is not much in it now after all the years that pharmacologists have spent in studying drugs from all over the world. So far as Chinese medicine goes, I know of several scientific treatises on the subject.

Interestingly, when in September some of you begin to sneeze, the ephedrin which you will probably find helpful was isolated only a few years ago from an old remedy used by the Chinese. It was purified by a young Chinese chemist, Doctor Chen, working in the laboratory of an American university.

ARE PHYSICIANS TOO CONSERVATIVE?

It is not very complimentary to us physicians that thousands of people believe that if some layman were to discover the cure for cancer we would have none of it until we were forced to give in. Actually, a study of the history of medicine in the last seventy-five years shows that our leaders have grasped eagerly at the gifts that have come from men outside our ranks: from a physicist like Roentgen (x-rays), from a chemist like Pasteur (bacteriology), or from a dentist like Morton (anesthesia). In fact one of our worst tendencies is to snatch the gift away from the giver before he has had time to perfect it or to test it properly.

Every year the institution in which I work receives many letters from men and women who assure us that they have the cure for cancer and ask that we help them in getting it before the world. What these people fail to see is that if a man were to cure only a dozen patients with cancer scattered through the body, he wouldn't need to come to us for help, instead he would have to appeal to the police each day for a detail to keep the crowds in order on his front lawn.

Actually, of course, there is not one chance in a million that the cure for cancer will be found by a layman or some obscure physician working nights in his basement. Just as in gold mining, so in medicine, the time for picking up big nuggets is gone. Now the finding of such a thing as a cure for cancer calls for much work by groups of highly trained and well-equipped investigators, and success is most likely to come as the result of a series of discoveries, all made in big university laboratories.

HIPPOCRATES, THE FATHER OF MEDICINE

But to get back to the beginnings of medical writing; let me tell you a little about the greatest of all the ancient books. Really it is a series of books written in large part by Hippocrates, he whom we now call the father of medicine. He lived and worked in Greece some 400 years before Christ. He was a modern type of scientific physician in that he observed closely with a surprisingly open mind; he described what he saw, he recorded his failures as well as his successes, and he used everything of curative value that he could find. As one would expect from this, much of what he wrote so long ago is still of interest and value

today. The few chapters that are of little value are the ones, possibly written by disciples, in which the facts of observation were warped to fit one of those unprovable theories of disease which are still so popular with irregular practitioners today.

As many of you know, the Greeks looked upon the world as made up of four elements: fire, air, earth and water, and the body of four humors: blood, phlegm, yellow bile and black bile. These humors were affected by the four qualities of matter: heat, cold, dryness and moisture, and disease resulted when a humor became too hot or too cold, or too dry or too moist.

You who know something of modern chemistry and physics will say: "How silly," and yet these humoral ideas dominated and restricted and largely sterilized medical thought for two thousand years. Even today, they affect our speech, and we say that a man is of a sanguine, a phlegmatic, a choleric, a bilious, or a melancholy nature, that he is good or bad humored, or that he has a warm or a cold temperament.

We physicians revere Hippocrates because he was the first man to teach, first, that many diseases clear up best if the physician does not meddle too much, and, second, that medicine can advance only when it breaks away from magic. Gradually, through the two milleniums before Christ, physicians had been coming to see that some diseases are due to injury and contagion and the wearing out of parts, but so far as we have a record, Hippocrates was the first to go the whole way and state that no disease is purely miraculous in origin. He would not exclude even epilepsy, which then was called the sacred disease, because of those terrifying fits which seem so obviously to be due to the intervention of a god or of a devil.

And if through the ages, religiously minded people had only listened to Hippocrates and had given his successors the freedom to dissect, to perform autopsies, to experiment on animals, and to report honestly and fearlessly what they found, how almost certain it is that today medical knowledge would be hundreds of years ahead of where it is, with tuberculosis and cancer and arthritis perhaps only memories of the past.

THE EVER-PRESENT OPPOSITION TO MEDICAL ADVANCEMENT

But all through the ages a large section of the people in every country have kept saying, "No, you mustn't do this and you mustn't do that," thus making it hard or impossible for physicians to carry on their studies and their beneficent work for the relief of human suffering.

Really, aren't we human beings curious in our mental processes? In the middle ages they loved to hitch a dray horse to each of a man's hands and feet and drive these horses off in four different directions; they loved to strip off a man's skin while he was still alive, or to break his bones on the wheel, or to roast him over a slow fire; but just let the crowd which had looked on so approvingly discover next day that an eminent teacher of medicine, trying to learn how better to help suffering humanity, had dissected what was left of the poor prisoner after the hangman was done, and they would turn in wrath to rend the impious wretch who had dared to so desecrate a human body!

But we must not smile at this in a superior way because even today, it is not always easy to get human bodies for dissection, and so bitter is the opposition of some animal lovers to the progress of scientific medicine, that in some cities the pound man does not dare to sell even a dead dog for study in the local medical school.

Just think of Aristotle, the greatest naturalist, and one of the greatest physicians of all time, having to admit that even with the backing of his pupil and patient, Alexander, the most powerful ruler of the then known world, he had been unable to dissect even one human body, and he had never seen a man's kidney or a woman's uterus!

It was not until the sixteenth century that the opposition to dissection of the human body died down sufficiently in a few Italian cities so that the great Vesalius was able to learn how a man is made inside, and to publish (in 1543) the first accurate book on anatomy. Obviously, until such knowledge was secured, the practice of surgery was impossible.

The next big step in the progress of medical science came in 1628 with Harvey's great discovery of the circulation of the blood. With this work was begun an era in which the functions of the many organs of the body were studied. In 1683, Leeuwenhoek discovered bacteria, and in 1719, Morgagni founded the science of pathology, which deals with the changes that are to be found in the bodies of persons dead of disease.

Later there came much progress in the differentiation of diseases by careful study of the symptoms and the physical findings, until physicians were able to distinguish malaria from typhoid fever, measles from German measles, diphtheria from croup, and appendicitis from ordinary stomach ache. Around 1887 Pasteur discovered the rôle that germs play in the causation of disease; protective vaccines and sera began to be made, and Lister showed how to banish suppuration from surgical wounds. In 1846, Morton and others discovered anesthesia, and surgery came into its own. Finally, with the development of bacteriology, there came wonderful triumphs in the prevention and cure of many of the infectious diseases that have plagued mankind.

THE LATEST PHASE OF MEDICAL PROGRESS

Today we are entering on a marvelous phase of medical development, and many seeming miracles are already being performed. The physiological chemist is having his inning, and every few months, someone discovers a new substance which has uncanny powers in the way of controlling growth and development. One of these substances makes giants, another makes midgets, another produces goiter, another makes the breasts of a virgin animal fill with milk, and other produce cancer at the will of the investigator. I feel sure that we are but on the threshold from which we shall soon glimpse even greater wonders.

As yet we do not know how to use curatively all these gifts of the chemist, and many are not yet even on the market, but with time and experience, there must surely come from some of them great benefits to the human race.

THE NEED FOR PROTECTING RESEARCH WORKERS FROM MISGUIDED PEOPLE

All of these great gifts of science are for you and your children. No one knows on what day some disease, as yet incurable, is going to strike down someone dear to you; and when that day comes the only hope your physician may be able to give you will be that in several laboratories in this country, or abroad, devoted men and women are working late into the night, hot on the trail of a cure for this very disease which now interests you so much. Under those circumstances the one thing left for you to do will be to pray that the discovery will not come too late.

Surely when such days of sorrow and anxiety come you do not want to have the door of hope slammed shut in your face with the announcement that certain people who cared for animals more than they cared for men and women and little children have succeeded in stopping work in those very laboratories in which this most promising work was going on. I am sure that most of you would never consent to such a thing if only you understood the problem, and if only you believed university authorities when they assure you that today laboratory animals are well taken care of, and, when operated on, are always kept under surgical anesthesia.

SUMMARY

In summing up, now, I would like to emphasize again that there are two types of medical practitioners that have been with us from the earliest times: One the witch doctor with his reliance on ancient magic and dogma, the other the herb doctor and primitive surgeon with his constant search for efficient methods of treatment.

Even today these two types of practitioner are to be found side by side, in every community, and strange mixtures of the two methods of practice are often compounded. Although scientific medicine is forging rapidly ahead and working ever greater miracles of healing, it still has to fight its way against opposition from the many people who have been brought up to believe that diseases can best be treated by one who has little or no education in medicine.

The story goes that once upon a time a man of God was treed by an angry mother-bear who started to climb up after him. At first the minister prayed for help but as the bear kept climbing higher, he modified his plea and begged only that the Lord not help the bear. And so I close with this request that while teachers of medicine and research workers struggle on to advance the progress of medical science and to supply you and your children with ever better and abler and finer physicians, will you please refrain from helping those many persons who are always trying to lower standards of medical education and licensure, and to stop work in the research laboratories. As Dr. John Abel, that grand old man of American medicine, once said, "Greater even than the greatest discovery is to keep open the way to future discoveries."

SEROLOGY AND BIOLOGICAL PROBLEMS

A BRIEF REVIEW*

ALAN BOYDEN

Bureau of Biological Research, Rutgers University

I. INTRODUCTION

Serology is that branch of physiology which deals with the nature and interactions of antigens and antibodies. All serological reactions probably involve at some point the body fluids of organisms, and most commonly, the sera of animals, hence the appropriateness of the term Serology. This term is broader than Immunology because certain serological reactions are not immunity reactions at all but lead to a condition of heightened susceptibility (anaphylaxis, allergy). All serological reactions involve two primary reagents, *viz.*, (1) *antigens,* which are substances capable of inducing the production of antibodies and (2) *antibodies,* which are substances produced in response to the injection of antigens, capable of combining with and reacting upon these and other chemically related substances. Of these two primary reagents the antigens are the better known, for they are common substances, such as complete simple or conjugated proteins, whose chemical nature is fairly well understood. Antibodies, however, are always demonstrated indirectly by their reactions upon antigens and their chemical nature is as yet imperfectly known. A common view is that antibodies may be in most cases altered serum globulins. A third kind of reagent may be involved in certain serological reactions, *viz., haptens,* which are often substances of lipoidal or carbohydrate nature, not antigenic in themselves but antigenic in association with protein and capable of reacting with antibodies produced in response to the injection of corresponding conjugate proteins.

The most fundamental principle of serology is this: Serological reactions are quantitatively specific. This means that any antiserum will react more strongly with the particular antigenic substance used in its formation than with other antigenically different substances. Doubts as to the validity of this principle have been raised by some, but so far such doubts are based on insufficient evidence to cause an abandonment of the principle. The fact that an antiserum may be produced in response to the injection of a mixture of substances and that another mixture (containing a higher proportion of the more active antigens) reacts more strongly with this antiserum than the original homologous antigenic mixture did is no disproof of the principle. The principle as stated will be disproven only in such a case as this, *viz.*, an antiserum against a particular antigenic substance will react more strongly with equivalent amounts of a different antigenic

* This review and a previous one entitled "Chemical Nature of the Vitamins," by Walter C. Russell, were submitted in accordance with a suggestion made by the Rutgers Chapter that the *Quarterly* publish one or two reviews from the various scientific fields in each issue. It is hoped that this plan will prove of interest to the readers of the *Quarterly* and that the various chapters will notify the Editor whether or not they approve the idea and transmit to him any further criticisms or suggestions regarding such reviews. The responsibility for these papers at the rate of two per issue would not be burdensome, for with the present number of sixty-six chapters, each chapter would need to provide a review but once in eight years. Surely the labor, if fairly apportioned, would never be excessive and the value of the *Quarterly* might be increased, especially for the younger members of the Society.—Marion A. Johnson, Secretary, Rutgers Chapter.

substance. No undoubted case of this kind has as yet been reported. As a matter of fact this quantitative specificity is the basis for all the theoretical and practical applications of serological reactions to biological problems. Thus, provided with antisera of particular kinds, the serologist may attack any problem involving the corresponding antigens. The following is an outline of the chief types of such problems:

I. The natures of antigens and antibodies and of the interactions between them.
II. The nature of serological specificity.
III. The study of the distribution of antigens in the world of life.
  A. Intra-individual distribution of antigens.
    1. In adult organisms—the antigenic constitution of protoplasm, cells, tissues, organs.
    2. Ontogenetic distribution—the time and manner of appearance of antigens and their importance in chemical embryology.
  B. Inter-individual distribution of antigens.
    The study of the antigenic constitution of individuals, races, species, and its bearing on phylogeny.
IV. Practical applications of serology in the diagnosis and prevention of disease; or in the identification of unknown antigenic substances.

Now of these problems, the literature relating to I and II is ably presented in Wells,[1] in the recent review by Heidelberger[2] and in the thorough discussion of Landsteiner.[3] The literature relating to IV is presented *in extenso* in Kolmer,[4] Jordan and Falk,[5] Taliaferro[6] and Gay.[7] Only the literature of III lacks a recent comprehensive review in the English language. But limitations of space compel a condensed summary and we shall limit this review to IIIB, and specifically to some significant contributions of the decade 1925-35 which deal with the precipitin reaction as it bears on phylogeny.

II. PROGRESS DURING THE PERIOD 1925-35 IN PRECIPITIN STUDIES OF PHYLOGENY

A. Plants

The most active worker in this field has been Carl Mez. The results of sixteen years of investigation by Mez and his colleagues and students were graphically portrayed by Mez and Ziegenspeck[8] in the form of the "Königsberger serologische Staumbaum." This journal (*Botanisches Archiv*) is not present in many libraries in this country but the phylogenetic tree is presented also in Gortner.[9] Mez[10] provides a comprehensive exposition of the significance of serology for phylogenetic research. Protein constitution is emphasized as the basis of morphological and physiological characteristics (the lipoids being removed from all antigens by alcohol and ether extraction) and the principles are laid down that (a) the characteristics of the proteins are determined by heredity; (b) proteins do not undergo convergent evolution or reduction, therefore serological evolution is irreversible; (c) the more similar the proteins in organisms the closer the phylogenetic relationship; (d) only nuclear proteins are serologically important

in relationship studies and these are the same in all parts of the body and at all times during the life cycle—hence, there can be no serological recapitulation; (e) parallel and reciprocal tests give consistent results; and (f) serological results indicating relationships can all be supported on morphological grounds. Now of these principles only one (*viz.*, "d" above) is clearly wrong as it applies to animals, at least, for we have excellent cases of serological reactions indicating relationship based on egg albumins or serum proteins which cannot be due entirely to nuclear proteins. Ziegenspeck[11] affirms essentially the same principles, gives a detailed exposition of the improved technic used, replies to criticisms, and shows the lack of serological convergence in plants morphologically convergent.

But there is another side to the story. Gilg and Schurhoff[12] and others cited by them, have used the precipitin test and have obtained results which were at variance with their ideas of the systematic positions of the species tested or were even mutually contradictory. These authors conclude therefore that the precipitin reaction gives results of doubtful phylogenetic significance. A second paper[13] reiterates the same views and claims on good grounds that the ring test used by them is superior in its dependability to the flocculation or conglutination tests employed by Mez. Unfortunately the technics used by these two groups of workers differed in other particulars, as Moritz[14] points out, and hence the conclusion that precipitin tests as made by Gilg and Schurhoff disprove the value of Mez's results is of doubtful validity. The paper by Moritz above referred to and others which appear later[15, 16, 17] are useful critiques of the investigations in this field of work. Moritz is correct in emphasizing that the precipitin reaction is lipoid sensitive but it is certainly not necessary therefore to abandon the precipitin test for the less quantitative anaphylaxis reaction. All that is necessary is that the lipoids be completely removed. All workers seem to agree that the ring test is easiest to read, and even though it is less sensitive than either the flocculation or anaphylaxis tests, it is more dependable than the former and simpler than the latter. If its range of reaction is less extensive, all that is necessary is that more centers of testing be employed and this is highly desirable anyway.

The rôle of lipoids in these tests was experimentally studied by Becher[18] and others who clearly showed the non-specific influence of alcohol-soluble or ether-soluble constitutents of the antigens and thus proved again the necessity of their complete removal.

Space will not permit the inclusion of many other papers cited in the references already given. We may briefly sum up the results in saying that phytoserological studies based on plant proteins give data of a crudely quantitative nature which, in the hands of some investigators, are fairly consistent and which support concepts of plant phylogeny already advanced on the basis of morphological studies. These results may properly be criticised on the grounds that they are only rough indications of relationships (especially of the more remote ones) but they cannot justly be criticised by those who work with antigens containing lipoids, or by those who, in spite of present contradictions in our interpretation of relationships based on form, insist that some one scheme of phylogeny is absolutely correct. More careful work with sources of error reduced to a mini-

mum will give us more exact information as to the antigenic natures of existing plants and especially regarding the evolution of their proteins. It has yet to be proven that the evolution of proteins is in general a matter of no consequence to the phylogenist.

B. Animals

In animals there is much less recent work in the field of the serological study of relationships than in plants. The fact is that since Nuttall's extensive study, published over thirty years ago, the contributions have been relatively few. Some progress, however, has been and is being made.

Boyden[19] reported the results of testing precipitin antisera produced by rabbits and fowls against common mammalian sera. The importance of (a) repeating tests and determining the errors of reading, and (b) using antigens in comparable concentrations, was pointed out and the use of reciprocal tests as a further check on the consistency of the results obtained was emphasized. These results confirmed in a small way those of Nuttall and contradicted opposing claims of the unreliability of the methods, made by a number of European workers.

A small series of experiments was described by Brown and Heffron[20] in which the relationships of a few species of lepidoptera were investigated by the precipitin reaction. The results agree with the probable relationships of the species tested and indicate the possibility that much useful work may yet be done with insects. Landsteiner's studies led him to the conclusion,[21] fundamental for all precipitin work, that there exists a two-fold system of species specificity in animals, *viz.*, (a) the specificity of proteins and (b) of cell antigens. To quote, "In the case of the proteins the serological and chemical properties in general parallel closely the zoological relationship and the changes are gradual. . . . Thus one could roughly construct the zoological tree merely on the basis of precipitin reactions" (p. 596). On the other hand, the specificity of cell antigens is characterized by heterogenetic reactions which are less perfectly correlated with systematic position. The fact that the words "roughly construct" are used above is no disparagement to precipitin studies for all phylogenetic trees, whatever their basis, are rough-hewn indeed.

Sasaki[22] reports success in the study of related species of water fowl being able to distinguish certain closely related species and to demonstrate relationship in less closely related species. In a later paper[23] the same author made similar studies on cattle and was apparently successful in distinguishing races such as the Aberdeen-Angus from Holsteins. The validity of methods yielding such distinctions depends upon the real equivalence of the antigens compared. If the method used by Sasaki to determine the protein content of his blood sera is satisfactory then the results become of unusual interest because such a serological distinction as to serum proteins between fully fertile races makes it possible to study the inheritance of the differentiating characters. Genetic knowledge of the mechanism determining biochemic constitution is admittedly weak and this apparent opportunity to add to it must not be overlooked. Wilkoewitz and Ziegenspeck[24] have reported the results of testing both vertebrate and invertebrate antigens with corresponding antisera. The results agree essentially with

some of the current views of animal phylogeny. I do not feel, however, that the technic employed was above reproach, for the antisera were for the most part "Kunstsera," which have been strongly criticised on the grounds of their non-specificity. Furthermore, no guarantee was given of the protein equivalence of the antigens as the work of Mez's school generally lacks protein determinations. More careful work is needed to confirm these results. Boyden and Baier[25] review the literature dealing with the measurement of the volume of precipitate obtained in the precipitin reaction and describe a fairly rapid method of obtaining consistent results on centrifuging. For what appears to be the first time in serological studies sufficient data are given of repeated tests to give a fair indication of the reliability of the readings.

Canning's[26] paper is a most interesting study of the specificity of various tissues of Ascaris and related helminths. A serological homology of tissues is clearly shown as well as a variation in the reactions of homologous tissues from different species of ascarids. A complete study of the serological relationship of two species must therefore require a comparison of the degree of similarity in all the antigens possessed by these species. Such complete comparisons are lacking in serological relationship studies and they are similarly lacking from most taxonomic studies based on form. But knowledge of either kind is helpful in determining relationships incomplete, as it may be.

Hicks and Little[27] report on the blood relationship of four strains of mice, the antisera being obtained by the injection of rabbits. The results indicate the serological identity of two of the species and the more distant relationship of two others. It is interesting that two of the species which are reported to be easily distinguishable by precipitin tests, *viz.*, *Mus musculus* and *Mus bactrianus*, readily hybridize and hence there is again the possibility of studying the hereditary behavior of the serum proteins in the parent species and in their hybrids. But this serological differentiation must first be confirmed, for it is quite unusual. Holzer[28] failed to distinguish by precipitin tests two closely related species of guinea-pig *Cavia porcellus* and *C. rufescens*. Unfortunately the antigens, used by Hicks and Little, though consisting of pooled bloods, were not known to be equivalent in protein concentration, and hence these data require confirmation in this regard. Some doubt also may be raised as to the right to compare directly antisera obtained by methods of immunization which differ in the length of time injections are made, for Magnus showed long ago that the range of reaction was broadened by prolonged immunization and the specificity correspondingly lessened and this has been recently confirmed by Wolfe.[29]

The most useful reviews of literature dealing with the results of serologic testing of animal relationships are those of Erhardt.[30, 31] In the former a summary is given of the investigations relating to birds and in the latter to all animals, vertebrate and invertebrate. The latter contains also a description of Erhardt's own studies involving antisera against both vertebrate and lower animals. As a result of his own work, and from the comparison of the results of others, Erhardt concludes that serological tests are of subordinate value in animal phylogeny. Useful as these papers are, Erhardt has apparently made two assumptions of doubtful validity: (1) that all serological studies are of equal rank and hence discrepancies indicate inherent unreliability and (2) that

the systematic relationships of animals are so well known that any discrepancies between the serological and morphological studies discredit the former. That these assumptions are false may be quickly proven for (1) the value of serological studies depends partly on the technic employed and this has varied markedly in the hands of different workers and (2) there is no complete agreement among taxonomists even as to the fundamental principles of their science, to say nothing of the interpretations of animal relationship they make and continually revise. It must, however, be admitted that up to now serological results do have a markedly subordinate value in animal phylogeny, but this is no guarantee that this situation will always continue. Certain results suggestive of the contrary view have been obtained by Boyden and Noble,[32] by Wolfe,[33] and by Boyden.[34] In the former a study of the relationship of certain common Amphibia led to an apparently successful solution of a long recognized problem in relationships. In the paper by Wolfe a great many tests give good agreement with systematic position. Reciprocal tests generally agree except with Carnivora. A tentative comparison of the values of the serological as compared with morphological studies of animal relationship is attempted in the last of the papers above mentioned. The two methods have each their inherent advantages and disadvantages and should rightly be considered complementary. The recent important paper by Wolfe,[29] already mentioned, confirms the earlier findings of Magnus and others and clearly indicates the necessity of using comparable methods of injection, especially as to the duration of the injection period, if comparable results are to be obtained. No doubt some of the conflicting results of early studies (including our own) is due to the failure to recognize this important technical consideration.

Finally mention must be made of a recent paper by Zuckerman and Sudermann[35] relating to "Serum Relationships Within the Family, Cercopithecidae" and including also tests with representatives of four other Primate families. These authors describe results of precipitin tests which do not correspond to the usually accepted systematic positions of the species tested. Their results show a relatively enormous range of variability of different samples of the same species of blood, a range as great as includes different families. Intraspecific variability as great as interfamily variability! This is something apparently new. Whereas most investigators (as the recent paper by Holzer[28] and the discussion by Landsteiner[3] indicate) have found difficulty in distinguishing closely related species by the precipitin test because of the conservatism of the serum proteins, and the experimental errors involved in testing; Zuckerman and Sudermann find that an anti-rhesus macaque serum reacts with its homologous antigen 100 percent, with two other rhesus antigens 43 percent and 7.6 percent, respectively, and with man, belonging to a different family, 4 percent! In view of the experience of other investigators to the contrary these results certainly need confirmation. Is it not peculiar that Zuckerman and Sudermann state (p. 227), "It is unnecessary to elaborate these facts, which so far as the Primates are concerned point to the obvious conclusion that the serum precipitin test, as generally employed today, *is incapable of distinguishing quantitatively between individuals of one species,* between species, and between genera of the same family" (italics mine)? It appears that both the data and their interpretation

are conflicting and confused. The usual result of repeated ring tests made by practiced investigators using rabbit antisera, is agreement within the limits of error of the test and this has been true whether one or more individuals of the same species have been used as sources of the antigens. In other words the ordinary precipitin test cannot distinguish between individuals of a species and usually fails even to distinguish between individuals belonging to closely related species. As a matter of fact most of the antisera which Zuckerman and Sudermann tested with these three different rhesus-macaque antigens failed to distinguish between them, and this fact makes the interpretation of the data all the more difficult. If repeated tests of the same kind, *viz.*, tests of one antiserum with its homologous antigen, and with other samples of the same species of antigen, fail to agree, it is hardly to be expected that the reciprocal tests should agree, yet Zuckerman and Sudermann appear to place all the blame on the reciprocal tests, overlooking the fact that the data they report are inconsistent in themselves. The principle of reciprocal relationships may not be universally applicable to the results of precipitin tests (we have already noted certain exceptions), but it is questionable whether the conclusion of Zuckerman and Sudermann "that the serum-precipitin test is of limited value in tracing phylogenetic relationships" is based on adequate fact. We are still making progress in eliminating sources of error in precipitin tests and only when the principles of technic are fully developed and still found wanting, will it be safe to deny the value of serum precipitin tests in the analysis of phylogenetic relationships.

It must be admitted that there is still a marked difference of opinion regarding the significance of precipitin studies of animal relationships. Fairly consistent results have been obtained by some workers, quite erratic results by others. As we have said before, it is much too early to give any final appraisal of the relative advantages and disadvantages of the serological methods of phylogenetic investigation. More and better work (and this applies to our own studies likewise) must still be undertaken. When all known sources of error are reduced to their absolute minimum we may speak with more assurance of the meaning of this work for biology.

III. PROBLEMS NEEDING INVESTIGATION. THE OUTLOOK TO THE FUTURE

Serology is a relatively young science. That phase of it which we have reviewed has attracted relatively few workers in comparison with other branches of biology. In consequence there are many fundamental problems which have been inadequately investigated or not touched upon at all. But what better place could there be than the journal of a research society to state these problems and to point out their possible biological significance? The following are perhaps the most outstanding of the problems which relate to the phylogenetic interpretation of precipitin studies.

1. What is the limit of individual variability in serum proteins within a species?

2. What is the hereditary mechanism which determines the characteristics of serum proteins?

3. How important are the relatively non-specific lipoids present in serum as factors influencing the precipitin readings?

4. Do the serological characteristics change during the life cycle and if so, just how much? Is there serological recapitulation?

5. Just what is the relation between the antigenic constitution of an organism and its morphological and physiological characteristics?

6. Will the more careful application of precipitin tests to Invertebrata help to solve the difficult problems of the real phylogenetic relationships of some phyla of uncertain systematic position?

Now these are all important problems. I do not know of any other biological field where answers to problems, *whether they be positive or negative,* could mean more. We are at present engaged in investigations which may give a partial answer to some of these problems. To date we have never found individual variability of homologous serum reactions to exceed the limits of error of the test as stated. In regard to[3] we have recently found a clear-cut case of convergence in serum reactions among Crustacea due to ether-soluble substances present in the sera. We shall proceed therefore with the removal of lipoids, thus eliminating one additional source of error in work of this kind.

The only discouraging thing is that progress is slow and careful workers are few. But this may be, after all, a blessing in disguise for we have time to work more carefully and to make reasonably sure of our conclusions before publication. We want only critical workers who are willing to take time to determine their own errors in the performance of the test, a prerequisite which but a small fraction of serologists have fulfilled heretofore. With good workers, the answers to these and other fundamental biological questions concerned with serology will slowly but surely come.

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ANTHROPOLOGY—YESTERDAY AND TODAY*

A. Irving Hallowell

Anthropology, customarily defined as the science of man, finds itself today in an increasingly anomalous position. For it is only one of a long series of disciplines, wholly or partially anthropocentric in their interests; among them zoology, anatomy, physiology, genetics, psychology, psychoanalysis, neurology, psychiatry, archeology, history, geography, sociology, law, political science, economics, linguistics. From workers in these diverse fields is flowing an increasing body of knowledge in regard to the phylogeny of man, the structure and functioning of the human organism in health and disease, and the patterning of human social relations under varying environmental and cultural conditions. It is unfortunate, I think, that any one discipline was ever forced to bear an appellation which logically should have been reserved as a collective term for *all* the sciences, or subdivisions of them, that have undertaken the investigation of any aspect of the life of man. In any realistic sense, all the disciplines contributing to the immense and varied body of data now available on our species are the "anthropological sciences."

It is true that anthropology has sometimes been used in a narrow sense, as on the continent of Europe, where the term is more or less confined to certain aspects of human biology or comparative anthropometry. But this limited usage has never been current in America. Since at this University anthropometry, as such, remains undeveloped, while other aspects of human biology fall within the sphere of the biological and medical sciences and outside of our department, I shall make no further references to a sphere of interest that elsewhere falls within the domain of anthropology proper. In view of the fact that Philadelphia was one of the earliest centers of interest in physical anthropology in America, and both the Wistar Institute and the University Museum contain important collections of skeletal material, it is unfortunate that it has not been possible for the University to support systematic research and instruction in this division of the human sciences.

Coordinate with the study of man as a physical organism, we have the disciplines—more recent in their emergence than the biological and physical sciences—that deal with human culture and social relations. These include the social sciences such as sociology, political science, economics, law, history and social or cultural anthropology. It is noteworthy that some of these disciplines, like political science and economics, specialize in particular kinds of human relations and confine their observations to western civilization for the most part, whereas law, history and particularly cultural anthropology, wander farther afield. Sociology, while more systematic and inclusive in its aims, has been preoccupied for the most part with social theory, and the social problems arising in our own civilization.

Meanwhile, social anthropologists, however specialized in their individual interests, have been devoting themselves as a group to the collection and record-

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ing of social, economic, technological, political, religious, linguistic and other data on the aboriginal peoples of the various continents. Many of these peoples are fast dying out, or their lives are being rapidly transformed through contact with western civilization so that in another half century or more, little may be left of their native manner of life. Anthropologists have also undertaken a considerable amount of archeological excavation in order to recover the material detritus of vanished peoples from which some aspects at least of their culture may be inferred. Where no written documents exist, the languages, social customs, religious ideologies, etc., of such people must forever remain inaccessible to us. Archeological excavations can never yield the rich and detailed information the social anthropologist is able to collect. For this reason, the immediate study of aboriginal communities that retain their native culture is imperative.

Thus, anthropologists have slowly been building up a corpus of material from various temporal periods and from different parts of the globe that supplements and enriches the more geographically and temporally limited data on the so-called historic civilizations of Europe, the Near East and the Orient. Without the anthropologists' contribution, practically no authoritative, detailed knowledge would be available in regard to the manner of life of an overwhelming majority of the world's peoples. Our information about the aborigines of the entire Western Hemisphere, for example, comprising peoples whose languages alone represent over 100 distinct lingustic stocks and whose culture types range from those of simple hunters to the elaborated and complex forms exhibited by the peoples of Yucatan, Mexico and Peru, would be limited to the accounts of missionaries, explorers, traders and casual travelers. The same is true in respect to the native populations of Africa, Oceania and a great deal of Asia.

In our habitual ethnocentrism it is too often forgotten that these aboriginal peoples and their cultures are just as intrinsically important in the total human picture as we are. From the standpoint of any genuine anthropological science they can no more be neglected than the plants and animals of their respective habitats can be ignored by systematic botany and zoology in favor of the exclusive study of European species. Yet in a recently published book, Prof. Harry Elmer Barnes, whose catholicity of interests no one would challenge, slips into the traditional ethnocentrism when he informs us that he is setting out to tell "the whole story of human development" and to present the reader with "the complete record of man's development on our planet" (a large order indeed). As a matter of fact, Professor Barnes, like others who have essayed to write "world history" or "the history of mankind," adheres pretty closely to his title, "The History of Western Civilization," even though he does use Paleolithic man as a convenient springboard.

The wide gamut of human communities studied, then, and the point of view arising from this fact, distinguishes cultural anthropology among the social sciences. Its approach is essentially comparative and from this standpoint the life of a people in the South Seas or Africa is of equal importance for an understanding of the total range of human behavior differences and human institutions, as that of the inhabitants of Middletown. Consequently some anthropologists have undertaken studies of communities of our own civilization as well as those of aboriginal peoples. Dr. Hortense Powdermaker, of the Institute of Human

Relations (Yale), for example, has recently studied a negro community in Mississippi, after having spent a year with a negro people in Melanesia, and Dr. Paul Radin has just completed a study of the Italians of San Francisco after having devoted most of his career to an investigation of different North American Indian communities. It is commonly thought, however, that all the peoples whom the anthropologist studies are unified by some general characteristics, usually expressed by the catchword "primitive," which sharply distinguishes them from ourselves, as well as other peoples of the so-called "higher" civilizations. In contrast with the latter, the subjects of the anthropologist are supposed to speak "primitive" languages (whatever they may be), produce examples of "primitive" art (the inspiration of some twentieth century artists of our own civilization), to entertain "primitive" religious beliefs (if they can be called religious), and so on.

The truth of the matter is, that the aboriginal peoples exhibit more diversity than similarity in their manner of life and often the complexity rather than the simplicity of their languages, social customs and ideologies, is the most striking thing to be noted about them. While the examples of Australian aboriginal art, that Doctor Davidson is going to show you, will no doubt correspond to the stereotype "primitive," this style of art is no more like that of certain African or native American peoples than that of western civilization. It cannot be viewed as typical of aboriginal or primitive peoples in any generic sense. It is simply characteristically Australian. On the other hand, if Doctor Davidson were to describe the social organization and complex marital arrangements of certain Australian peoples, it would require elaborate charts and diagrams and you might leave this meeting with a headache. Simplicity in one aspect of culture does not imply simplicity in others. Simple and complex are terms more easily applied to this or that culture phenomena, rather than to cultures as a whole.

Psychological criteria, I may add, have proved equally unsatisfactory when attempts have been made to define the characteristics of a "primitive mentality," or, by a battery of intelligence tests, to distinguish inferior and superior races.[1] What we do find among all peoples, of course, is a wide range of native abilities. But why we should ever expect to discover some intrinsic correlation between such anatomical traits as hair form, skin color, stature, etc., on the basis of which racial types are classified, and a functional trait such as intelligence, is not clear to me. We certainly do not infer that our blue-eyed friends are more or less intelligent than our brown-eyed ones, or that shortness of stature forever debars one from a high I.Q. Besides, not even the dimensions of all the body parts form a system of dependent variables. Certain head measurements, for instance, show a variability uncorrelated with other dimensions.

Primitive, in short, is one of those weasel words, only used by contemporary anthropologists in a rather loose and ill-defined sense. The attempts that are made from time to time to seriously define a category of the primitive, actually represent one of the last gasps of the abortive nineteenth century efforts to establish a series of developmental culture levels, in some sort of evolutionary scheme. At this earlier period, not only anthropologists proper, but students in other disciplines which dealt with the broad historical aspects of human affairs were all inspired by the theory of evolution as developed in the biological

sciences. Borrowing the generic idea, they thought that forms of marriage, religious beliefs, art form, etc., proceeded in a more or less uniform linear succession for mankind as a whole, or even in a parallel series of stages among widely separated peoples. The primitive peoples, according to this conception, were those on the lower stages of the series, even though they existed as our contemporaries. Without going into all the reasons for the rejection of these theories—except to point out that no laws of cultural succession have ever been demonstrated and that no genuine historical evidence has ever been adduced in support of them—it will suffice to be dogmatic and assert that practically all such schemes have suffered a complete collapse. It is therefore somewhat paradoxical that in contemporary Soviet Russia, a Marxian version of pseudo-evolutionary cultural development is being rehabilitated as the "theoretical" historical basis of communist "social science." Consequently, Lewis H. Morgan, author of the book (Ancient Society, 1877) embodying the most notorious exposition of the theory of social evolution and the most renowned American anthropologist of the nineteenth century, is almost as highly revered as Marx and Engels and Lenin.

One of the most damaging lines of attack on evolutionary theories was the demonstration of the importance of diffusion in culture history. Ideas, customs, technologies, etc., constantly spread from one people to another. Outright invention is a much less frequent phenomenon in human history than was once supposed, however important this process may have been in certain epochs. Few if any peoples have persisted for any length of time entirely cut off from other peoples, so that contacts between groups of different cultures have been one of the chief stimuli to culture growth and change, rather than invention, some "law" of social evolution or racial superiority. Thus some of the so-called primitive peoples have failed to develop new cultural forms because they have been cut off, or have been relatively isolated from the centers of major cultural innovation, rather than because of some psychobiological inferiority, or primitive mentality.

The theory of cultural diffusion, as might be expected, has been pushed to extreme lengths by some scholars. Thus Professors Elliot-Smith and Perry believe Egypt to have been the center from which all the higher cultures of the world—including those of Middle America—spread. Nevertheless, the importance of cultural diffusion as a process cannot be disputed. It is demonstrable that most peoples have borrowed more than they have invented, Europeans not excepted. Have European peoples been responsible for the domestication of the animals and plants they use today? Did they invent metallurgy, the alphabet, paper, the numerical symbols now in use, place value, and the concept of zero? And what about Christianity and the week? Likewise among the Indians I have been investigating, not a single character, plot or episode in their mythology occurs, that is not widely distributed among other native American peoples. Furthermore, early contacts among aboriginal peoples seem to have sometimes taken place over amazingly wide areas. Diffusion, then, rather than evolution, is the key to many developments in the history of human culture. Linguists, historians, archeologists and students of art are, of course, as vitally concerned in the illumination of this process as are anthropologists.

A contemporary aspect of the diffusion process is also of concern to sociologists, psychologists and administrators of native affairs, as well as to anthropologists. There are few native peoples at present who are not subjected to the necessity of adapting themselves in a greater or smaller degree to the customs of western civilization. Many are in the midst of an acculturation process which is transforming their lives. From a scientific point of view, this affords an opportunity to study at first hand how the assimilation of new social customs, religious ideas, food habits, etc., actually takes place; an important historical process can be studied in operation. And from the practical standpoint—as in our Indian Bureau—the administrator wants to know how far it is desirable to accelerate the process or slow it up. We may all agree that liquor consumption should not be encouraged on the part of the Indians. But what about the inculcation of the economic motivations peculiar to our capitalist culture as compared with those fostered by native economic systems? And how far should the complete destruction of native religious beliefs and customs be encouraged? In the past, of course, we have simply assumed that these latter could be eliminated, root and branch, but the process has not been studied carefully in respect to the effects produced in the lives of the individuals concerned. For obviously enough, psychic strains and stresses must be set up through the conflict of new ideologies with the old. It is a paradox that, in a period when orthodox Christian beliefs are far from unchallenged in western civilization, fundamentalist doctrines of the crudest type are being fed to aboriginal peoples the world over, all of whom have their native religions. Future historians may indeed marvel as our effrontry in this regard.

So far as aboriginal religious beliefs are concerned, it may be of interest to note in passing that an Austrian school of anthropologists, who have been responsible for one onslaught upon evolutionary theories, has succeeded in demonstrating that monotheistic beliefs, instead of being the flowering of a long period of evolution in religious ideology, are typical of many aboriginal peoples. Although by no means adhering to all the tenets of this school of anthropology, Professor Speck and myself have found that several groups of Algonkian peoples we have studied in recent years, entertain such native beliefs.

In my opinion, one of the most fruitful results of social anthropology is the opportunity now afforded to utilize the comparative data accumulated as a frame of reference for a more profound and detailed understanding of the determinants of human behavior and human relations. While we will never have complete data on all the varieties of human culture that have existed since the human race began, the samples available today are more adequate than ever before and fresh information is still to be collected in various parts of the world. The more intensive investigations of human behavior, within the framework of the traditions of western civilization, have somewhat blinded us to the control data offered by the amazingly different patterns of social behavior exhibited by human groups, when viewed in wider temporal and spatial horizons. These differences are all the more striking in view of the phylogenetic unity of man and even the specific identity of contemporary races—for their differences are relatively insignificant taxonomically. The use of such comparative data has far-reaching

implications for the disciplines approaching human behavior from various points of view.

Modern anthropology has stressed the point that this variability in human behavior is due to the fact that it is characterized by the quantitative dominance of *acquired* behavior patterns, in contrast with the more inherently determined responses, and consequently less plastic behavior, of the infra-human organisms. Transmitted from generation to generation in the form of folkways, mores, customs, beliefs and technics, these acquired forms of behavior comprise the cultural, as opposed to the organic heritage of human beings. For the modal or typical forms of these traditional ideas and action systems which characterize all human groups, the anthropologist has adopted the generic term—cultural pattern—an abstraction useful in dealing objectively with the predominant forms of group behavior shared by a series of human individuals. In our society, for example, every seventh day of a conventional division of time, called a week, large numbers of individuals dressed in clothes not usually worn the other six days of the week, leave their houses and walk or ride to certain buildings where they sit or sometimes kneel for a certain period of time. This is not organically determined behavior intrinsically native to our species. Other members of it never behave this way during the entire course of their lives. But through the accident of birth and biography large numbers of our population act in this way. It is a part of the religious culture pattern of our society to which these individuals are conditioned. In other human societies, religious culture patterns demanding quite different types of behavior prevail.

Quite aside from historical questions, it is very impressive how extremely diverse religious patterns are, to say nothing of other aspects of culture. When considered in connection with the fundamental organic unity of man, this diversity of human behavior patterns as a whole is a phenomena unique among living things. Thus it is man's culture that makes him human, in a behavioristic sense, rather than his organic make-up, as such. "Human nature," therefore, must be viewed as a variable, rather than as something constant. What is constant is man's particular variety of a phylogenetically derived primate equipment. There is nothing even specifically human, *e.g.*, in the sexual impulse; as Dr. G. S. Miller[2] has shown, human sex behavior fits the generic primate pattern. But the characterization is incomplete if we leave it at that. What we fail to include are the important differences in the culture patterns of mankind that canalize sex behavior and give the sex act totally distinct meanings. Incest prohibitions, *e.g.*, are a distinctly human phenomena, inconceivable without distinctions made possible by speech and customs by means of which different classes or kin are defined. But what is considered an incestuous act in one society is not so considered in another. The same is true in respect to what constitutes marriage, adultery, etc. Yet all these involve the same act *biologically* viewed. The significance and meaning of the sexual act in different societies, therefore, is a function of the culture patterns of that society, not of man's primate nature.

Man's behavior then is everywhere canalized, restricted and defined by customary procedures that are imposed upon each new generation of human individuals in accordance with the demands of different culture patterns. Verbal communication is patterned by conventional linguistic forms. Beliefs offer

standardized interpretations of the meaning of the physical phenomena of the outer world and support a reification of mythological beings. Inter-personal relations are guided by the traditional forms of the social and economic order. Even perception itself, and mental imagery, are not free from the influence of culture patterns, nor are gestures, the expression of emotion and the motivations of the individual. Character formation and personality are also moulded in terms of the culture patterns predominant in different societies.

Thus the values stressed in one society may be antithetical to those favored in another, but we have no absolute standard of reference by which to judge their intrinsic worth. In each case, they are a function of specific culture patterns. Values themselves thus become a matter open to objective investigation and to the student of the future, the predominant values of our capitalistic culture may prove just as curious as those of some of the aboriginal peoples do to us.

Since the so-called primitive peoples exhibit cultural patterns that diverge so markedly from our own, the contrast perspective afforded by the study of them must ultimately be taken into account by many, if not all of the anthropological sciences. If we are ever to establish a solid foundation for valid generalizations in these disciplines, observations made solely upon individuals habituated to the culture patterns of western civilization must be checked by observations on human groups with other traditional patterns.

Many important questions arise as soon as we do this; questions which challenge common assumptions implicitly or explicitly made. Some primitive peoples, *e.g.*, do not wage wars, or even have a term for war. Is man then "naturally" pacific and are aggressive impulses encouraged and abetted by certain types of culture patterns and not by others? Are women more "naturally" masochistic than men? Popular opinion as well as the psychoanalysts would encourage us to believe so, and yet recently Dr. Karen Horney[3] has challenged this view by pointing out the influence of different culture patterns upon the conditioning of feminine behavior and the attitude towards women in different human societies. Dr. Margaret Mead has also shown[4] how in certain New Guinea tribes what we have assumed to be sex-linked traits of temperament and personality are either reversed as in the case of the Tchambuli, "with the woman the dominant, impersonal, managing partner, the man the less responsible and the emotionally dependent person," or where, as among the Arapesh, *both* men and women display a personality that "out of our historically limited preoccupations, we would call maternal in its parental aspects, and feminine in its sexual aspects, while in contrast to both of these peoples in another New Guinea tribe—the Mundugumor—*both* men and women were "developed as ruthless, aggressive, positively sexed individuals, with maternal cherishing aspects of personality at a minimum." Both sexes, according to Doctor Mead, "approximated to a personality type that we in our culture would find only in an undisciplined and very violent male."

Our concepts of normal, abnormal and pathological also receive a shock, once the comparative data of social anthropology are considered. "In how far are such categories culturally determined?" asks Dr. Ruth Benedict, in a recent article, "Anthropology and the Abnormal,"[5] "or in how far can we with assurance regard them as absolute? In how far can we regard inability to function

socially as diagnostic of abnormality, or in how far is it necessary to regard this as a function of the culture?" . . . .

"As a matter of fact, one of the most striking facts that emerge from a study of widely varying cultures is the ease with which our abnormals function in other cultures. It does not matter what kind of "abnormality" we choose for illustration, those which indicate extreme instability, or those which are more in the nature of character traits like sadism or delusions of grandeur or of persecution, there are well-described cultures in which these abnormals function at ease and with honor, and apparently without danger or difficulty to the society."

Trance, catalepsy, homosexuality, etc., have over and over again been woven into the approved personality patterns of various human cultures. "Many of our culturally discarded traits are selected for elaboration in different societies. . . . . (We must not) identify our local normalities with the universal sanities."

Thus as Professor Sapir has pointed out,[6] "cultural anthropology . . . . has the healthiest of all scepticisms about the validity of the concept 'normal behavior.' It cannot deny the useful tyranny of the normal in a given society but it believes the external form of normal adjustment to be an exceedingly elastic thing. . . . It is valuable because it is constantly rediscovering the normal. For the psychiatrist and for the student of personality in general this is of the greatest importance, for personalities are not conditioned by a generalized process of adjustment to 'the normal' but by the necessity of adjusting to the greatest possible variety of idea and action patterns according to the accidents of birth and biography."

Comparative cultural data from other societies than our own are also relevant to the rôle that non-organic factors play in the etiology of certain classes of mental disorder. The psychic stresses set up by the limitations imposed upon the instinctual drives by one set of cultural factors in a given society are not precisely like those set up in some other society. Moreover, all the clinically recognized types of psychopathological disorders found in western civilization are not found in all aboriginal societies. But in certain of the latter, psychoses that assume typical forms, sometimes appear. Consequently there appear to be differential factors involved—irrespective of race, climate or constitutional type—that apparently are connected with variations in culture patterns. A new angle of attack on old problems can be envisaged from this point of view by the utilization of some of the data of cultural anthropology. But investigations in the field are primarily needed. I have discussed some of the preliminary problems involved in two recent papers—"Culture and Mental Disorder"[7] and "Psychic Stresses and Culture Patterns."[8]

A changing attitude towards the determining factors in the psychology of adolescence is a further example of how important an evaluation of the rôle of culture patterns is, with respect to the typical behavior of individuals. Prof. Gardner Murphy writes:[9]

> "A generation ago, as a result of Stanley Hall's interest in and study of adolescence, this period was supposed to have special and peculiar characteristics dramatically developing at the moment of puberty. Subsequent investigations have tended to show that this clear-cut division of adolescence from the earlier and later periods is probably not justified; in fact, that for many young people, the changes which are involved in

adolescence are no more startling and no more sudden (in our culture) in their development than the changes which come during, let us say, the period from 2 to 4 or 8 to 10. Some special studies of religion, *e.g.*, and negativism, have shown that even such clear-cut characteristics of adolescence as we can now admit to exist are not completely dependent by any means on the mere effect of maturation. On the contrary, environmental differences of the sort which result from gross occupational or social differences, relations with one's immediate family, as well as the wider culture patterns of the group, are extremely important in determining not only the extent but the actual existence of the *Sturm und Drang*, once considered an inevitable part of growing into manhood or womanhood. Indeed, it seems likely, as Mead suggests, that even the emotional instabilities and tensions involved in the new sex adjustments of this period are in large part tied up with, if not the result of, the particular emotional and thought patterns which our civilization imposes upon our young."

Miss Mead[10] reached this conclusion, I may add, as a result of her observations of Samoan girls. She found that they lacked the typical psychological syndrome of adolescence once assumed to be generic for all human beings.

These examples are sufficient, I think, to indicate how radically some of our assumptions about "human nature" and human behavior and its determinants may have to be revised in the light of observation made in other societies. When even more precise investigations are undertaken, than any now available, in order to determine the actual processes by which the character and personality of human individuals is moulded by diverse culture patterns and what factors are responsible for social and mental deviations in terms of these varying frames of reference, even more illuminating data undoubtedly will be forthcoming.

By substituting a genuine *human* perspective for the more narrowly circumscribed outlook that implicitly identifies human behavior with the *characteristic* behavior of man in contemporary western civilization, the anthropological sciences may some day achieve a genuine synthesis. It is hoped that the information being collected by social anthropologists on the cultures of the so-called primitive peoples, may contribute materially to this end.

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